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ABSTRACT

A discussion session provided opportunities for individuals involved in science teacher education to exchange approaches and ideas on how equity issues in science teaching and learning are being addressed in science teacher education courses. Evaluative questions included: (1) What conceptions of equity in science education underpin individual approaches? (2) What approaches are being used to address issues of equity in science education? (3) What issues and challenges are being confronted in teaching related to these issues? and (4) How are these issues and challenges being resolved? Appendices include two descriptive research papers presented during the session: (1) "Equity from a 'Holistic' Perspective Based on Student-Generated Artifacts" (Katherine C. Wieseman); and (2) "From Parallel Universes: Building Equitable Classroom Environments from the Ground up through Science and Special Educators' Collaboration" (Eric J. Pyle). (Contains 31 references.) (CCM)

ADDRESSING EQUITY WITHIN SCIENCE EDUCATION COURSES: SHARING APPROACHES AND IDEAS

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Orientation to Session

The purpose of the session was to provide opportunities for individuals involved in science teacher education to exchange approaches and ideas about how equity issues in science teaching and learning were being addressed in their science teacher education courses. Several questions served as a framework for panelists' contributions and subsequent discussion:

- What conceptions of "equity in science education" underpin our individual approaches?
- What approaches are we using to address issues of equity in science education?
- What issues and challenges are we confronting in our teaching related to these issues?
- How are we resolving these issues and challenges?

Conceptions of Equity in Education: The Many "Faces" of Equity

Equity can be defined as having "many faces," and mean different things to different people (Division of Elementary, Secondary, and Informal Education, 1997). Kohl and Witty (1996) suggest that equity is a "value," and is not synonymous with equality. Equity in education has been described as "equal distribution of resources" or "equal quality of the educational experience," encompassing a set of beliefs about how people should be treated and schools should be teaching children (Division of

Elementary, Secondary, and Informal Education, 1997). Grant and Billings (1997) assert that equity in education goes beyond equal opportunity, and addresses learners' individual differences and needs in curriculum and instruction. According to Secada (1994), equity refers to examination of social arrangements underpinning schooling to judge the extent to which these arrangements are consistent with standards of justice.

Educational equity has been identified as a principle of the modern multicultural educational movement in the United States (Hidalgo, Chavez-Chavez, Ramage, 1996), and education in general (Kohl & Witty, 1996). It is also highlighted in the current rhetoric of science education reform. Educational equity is embedded in the idea of quality science for all students, and is mentioned in several national standards (NRC, 1996). At the state level, learning frameworks or standards are giving varying levels of consideration to the goal or principle of equity in science education (e.g., CCSSO, 1997; GIMS, 1996). In contrast, Rodriguez (1997) argues that the National Science Education Standards "uses a *discourse of invisibility* to lay out its massive science education reform" (p.19) which compromises the intended goals of this contemporary reform effort.

Regardless the level of the student – practicing teacher, prospective teacher or K-12 student – creating equitable education continues to challenge the educational community (Division of Elementary, Secondary, and Informal Education, 1997). The dialogue about equity in education includes groups with interests in gender, race/ethnicity, learners with special needs, class, language, religion, and sexual preference. The inclusion of students with special needs has emerged as an equity issue of particular interest, particularly as our abilities to detect and measure special needs are becoming increasingly efficient. This has created a revenge effect (Tenner, 1997), such that as our capacity to detect special needs has increased, so has our moral and legal responsibility to accommodate students with special needs in schools.

Session Format

Panelists and participants engaged in an interactive forum primarily organized by the use of small group discussion. Panelists described their approaches or practical ideas for addressing equity issues in science teaching and learning, challenges and resolutions. Sharon Lynch facilitated group discussion about a model for characteristics of effective teachers of diverse populations for science education reform. Katherine Wieseman and Lynn Bryan co-facilitated a discussion about their approaches for addressing equity from a "holistic" perspective. Penny Hammrich facilitated discussion that was "all over the board" as well as focused on two questions. Are teachers' expectations about participation equitable practice? What are useful resources to cause students to examine their beliefs and teaching practice? Schedule conflicts and adverse weather conditions prevented the discussion focused on equity from an inclusion perspective from taking place, though it is partly represented in a paper by Eric Pyle. Two panelists, Wieseman and Pyle, each prepared papers or handouts; respectively, "Equity from a 'holistic perspective' based on student-generated artifacts" (see Appendix A) and "From parallel universes: Building equitable classroom environments from the ground up through science and special educators' collaboration" (see Appendix B).

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APPENDIX A
EQUITY FROM A "HOLISTIC" PERSPECTIVE BASED ON STUDENT-GENERATED ARTIFACTS

Katherine C. Wieseman, Western State College

Visualization and art can be powerful means for reconstructing life and professional experiences in order to examine their meaning and reveal beliefs underpinning action. I ask my education students to use their visual memory as a basis for self-reflection and analysis. I would like to open our examination of equity from a "holistic"perspective with a modification of a strategy that I use in my teaching, and have it serve as a way to introduce my approach to addressing equity in science teacher education. Subsequently, I will describe the conceptual framework underpinning my approach and the approach. Finally, I will overview what I have learned from my education students about their visions and understandings of themselves as equitable teachers of science.

Visualize Yourself ...

I ask you to shut your eyes and listen to the questions posed. As I pose these questions, paint a mental picture. Your picture may be in color or in black and white. It might be a series of still snapshots or a series of moving images. The goal is to reconstruct a recent teaching experience in one of your education courses.

Ready? (Pause) Okay, shut your eyes.

(In a quiet and soothing tone, and pausing at the end of each statement or question) What was the last course you taught? See yourself in one of the class sessions with your students. What is the topic of the session? What are your goals for today's session? What are your intentions? What do you hope your students will understand? Where are you? Is it a room or the outdoors? Are their any smells? Any sounds? What are they? If you are in a room, what is in the room and how is it arranged? What is beyond the room? Where are the students situated? What are they doing? Where are you? What are you doing? What are you thinking? Let the class session begin and progress. Just watch the scene as it unfolds and minutes go by. Notice body language – posture, facial expressions, gestures, movement, and interactions. Notice verbal language, voice tone, and inflection. Watch more minutes pass. Now what's happening? As you get closer to the end of the class session, notice how it ends. How does it end? When you arrive at the end of the class session, raise a finger or your hand and open your eyes.

Jot down on a piece of paper what it means to you to be an equitable teacher. (Pause) How are these ideas reflected or not reflected in what you visualized? Whose learning was favored and disfavored during your visualization, and how did this occur? (Time for sharing)

A Conceptual Framework

Equity is a word with many meanings and evokes thoughtful as well as emotional discussion and debate. Equity in education has been described as a value (Kohl and Witty, 1996), "equal distribution of resources" or "equal quality of the educational experience" children and a set of beliefs about how people should be treated and schools should be teaching children (Division of Elementary, Secondary, and Informal Education, 1997), a commitment to addressing learners' individual differences and needs in curriculum and instruction (Grant and Billings, 1997, an examination of social arrangements underpinning schooling to judge the extent to which they are consistent with standards of justice (Secada, 1994), a principle of the modern multicultural educational movement in the United States (Hidalgo, Chavez-Chavez, & Ramage, 1996) and and goal of contemporary education (Kohl & Witty, 1996; NRC, 1996).

Equity in science education – what does this phrase mean to me? Kohl and Witty's suggestion that equity is a value most closely relates to the conceptual framework underpinning the approach that I use in my teaching. Equity is a value guiding my actions and interactions in all realms of life, both professional and personal, and is based on seeking and celebrating diversity! This celebration demands awareness, sensitivity, a commitment to practicing nonjudgmentalism, valuing the uniqueness of each individual

whose life path intersects with my own, and seeking and understanding commonalties we might share.

Awareness, sensitivity, respect and valuing diversity has constituted the fabric of my existence. The environment in which I was raised was multicultural. My father immigrated to the United States. My mother, born and raised in America, has a longstanding and deeply rooted appreciation for cultures of other countries. My parents chose to raise my two sisters and me in yet a third country, Venezuela. Political and geographic boundaries were irrelevant to the childhood friendships and social relationships I established. Later, as a young adolescent and adult living and working in the United States, I continued to live betwixt cultural and social groups. I lived in "multiple worlds" and was a "border crosser" (Aikenhead, 1998). I still am. Four and a half years ago my professional identity began to be defined through responsibilities as a science teacher educator, first as a doctoral student at the University of Georgia and now as a teacher educator at a liberal arts college nestled in a mountain community in Colorado.

Beforehand, I posed the question, "Equity in science education – what does it mean to me?" I return to this question. The foundation for my response to this question rests in what it means to be human in the context of schooling and education. To be human is to be a composite representation of a spiritual, intellectual, emotional/affective,

physical being (Wieseman, 1998). To be the teacher educator I want to be calls for an ongoing and lifelong commitment to learning about and acting with conscious awareness and understanding of this definition of humanity. It is a journey of revealing, evoking, articulating and changing beliefs and attitudes (Rokeach, 1968). The nature of this journey is spiritual and holistic in orientation (Halford, 1998;Palmer, 1998) and must be evident through congruence between verbal language and action. The journey is oriented within (toward self) as well as toward others. My dream and desire is that the education students who sit my courses and who I advise engage in lifelong journeys of a similar orientation.

One Approach

In the teacher education classroom, as a facilitator of my and my students' journeys, I endeavor to provide diverse opportunities for students to: (1) express and examine their world views and teaching philosophies; (2) become informed of the social, cultural, psychological, and emotional dimensions of preparing to be a teacher; and (3) develop their professional knowledge (Connelly & Clandinin, 1988; Shulman, 1986). I embed attention to equity issues into discussions, actions and interactions when and wherever possible throughout the course, as well as highlight equity in science teaching and learning as an independent class sessions. This framework could be labeled as an equity-based approach (Bailey, Scantlebury, & Letts, 1997).

Besides the stories and cases that I share from my professional experiences as a teacher, I ask students to generate artifacts to guide their reflective processes. Their artifacts serve as a primary source for their explorations of self and others, and have included:

- Two-dimensional graphic representations of students' visions of themselves as teachers of science accompanied by a written narrative;
- Representations of students' visions of themselves as "equitable" teachers using any form of expression accompanied by a written narrative;
- Written reflective narratives about their teaching experiences during the methods course
- Written responses to questions such as, (1) When you think of "fairness" in teaching, what does this mean? (2) What does equity in learning science mean to you? (3) What does equality in learning science mean to you? (4) Are equity and equality the same or different things? (5) How do equity and/or equality relate to "fairness" in teaching?
- Analysis of their artifacts in relation to professional literature as synthesized in course handouts disseminated during the class sessions specifically highlighting equity issues in science teaching and learning (e.g., Aikenhead, 1998; Anderson, 1988; Keller, n.d.; Melear, 1995; Murfin, 1994; Ogawa, 1995)

Students ' expressions, using diverse media, stem from visualization, life experiences and the professional literature.

Prospective teachers' visions and understandings

Student-generated artifacts can be a powerful vehicle facilitating their endeavors to articulate, express and understand personal world views and teaching philosophies. The following synthesis reports themes in students' visions and understandings of themselves as teachers of science. The synthesis is based on three diverse groups of prospective teachers. One group, prospective teachers of middle level science, were education students in an Early Childhood program at the University of Georgia. The two other groups, prospective elementary teachers and secondary science teachers (middle and high school), are education students in the Teacher Education Program at Western State College.

Emergent themes in students' graphics and narratives communicating their visions of themselves as teachers of science were goals of science teaching and learning, the nature of the science learning environment, the nature of science, developmentally appropriate ways to learn science (e.g., hands-on), the nature of learners, teacher roles and responsibilities, and school-family connections. Emergent themes in students' analyzes of their teaching for types of learners favoured and disfavoured centred on learners prospective teachers disfavoured, namely learners who have difficulties (as a

function of English language proficiency, cognitive ability, special learning needs), are "bright" and "have a great deal of knowledge," are less interested or enthusiastic about learning, hold creationist views, and/or have learning styles or thinking approaches different from the prospective teacher.

In their visions of themselves as teachers of secondary science, the prospective secondary teachers (N=6) communicated their views about the goals of science teaching and learning and the nature of the science learning environment. For them, it was important that their future students develop understanding of the world and scientific knowledge and understanding. As a prospective biology teacher indicated, "I believe students must be able to leave school with a certain understanding of the entire world and at least a hint of some direction that they may wish to pursue" (August 1998). As a prospective earth science teacher wrote, "My goal is to make them realize that what they see on the Earth today is not how it always was, and it will not remain the same. ... They should understand that the rock that makes up the mountains they see was once the bottom of a shallow sea or the surface of a desert" (August 1998). The science learning environment, though predominantly set in a classroom was not restricted to this physical space. When students were mentioned, they were referred to as aggregate entities; for example, "I want to apply my teaching to the students' futures as well as their present life situations" (August 1998).

In the analyzes of their teaching for types of learners they favoured and disfavoured, most of the prospective secondary teachers reported that they disfavoured students who "don't get the material quickly" and "who needed more assistance." This tendency was attributed to "the problem of not fully understanding the cognitive ability of the student" or lack of awareness until the prospective teacher had observed their video taped lessons. They also thought they slighted students less interested and enthusiastic in science, which, according to several prospective teachers, were the girls in the classroom. One prospective teacher also indicated disfavouring students whose thinking approaches (i.e., relational and holistic) as well as views of science (i.e., "a creationist point of view") were different from his own.

The prospective middle school teachers (N=48) expressed their views about goals of science teaching and learning, the nature of the science learning environment, the nature of science, developmentally appropriate ways to learn science, teacher roles and responsibilities, school-family connections, and/or the nature of learners in their visions of themselves as teachers of middle school science and as equitable teachers of science. Like the prospective secondary level teachers, middle level teachers believed it was important that their future students develop a scientific understanding of the world in which they lived. Like the prospective elementary level teachers, they emphasized hands-on science.

Two emergent themes for this group of prospective teachers, unlike the other two groups, were learner differences and "treat[ing] them [students] all equally." The most commonly mentioned attributes of learner differences were race, ethnicity, gender, disabilities, "way of learning" and religion. In the words of one prospective teacher, "children are unique and have different interests, abilities and needs ... and it's my job to adapt to the students' way of learning." Other students, however, claimed they would "treat them [students] all equally," regardless of differences between learners. Equal treatment of students was regarded to be equitable practice: Equality = equity. For instance, "I will not discriminate against any race and will treat everyone as an equal" and "treat them all the same -- with love." With respect to their perceptions about themselves as equitable teachers, essential qualities included being flexible and able to assume diverse roles ("wearing many hats"), and exhibiting respect, concern, compassion and sincerity toward their students.

Based on their analyzes of teaching experiences, the prospective middle level science teachers reported disfavouring several types of learners. This list included: students having difficulties (stemming from limited proficiency in English, learning disabilities, attention deficit disorder, and physical and mental challenges); students not in close proximity of the teacher; students who are "quiet" and do not volunteer comments or ask questions, nor do they raise their hands; students with a creationist

orientation; students "who may know it well;" and students with learning styles different from the prospective teacher's (i.e., kinesthetic and/or visual learners).

The prospective elementary teachers (N=3) focused on the goals of science teaching and learning, developmentally appropriate ways to learn science, and the nature of the science learning environment in their visions of themselves as teachers of elementary science. For these prospective teachers, the best way to learn science and for children to develop an understanding of their world was through hands-on learning. Their initial conception of hands-on learning, commensurate with an "activity-mania" orientation (Moscovici & Nelson, 1998), at the end of the term shifted to an inquiry orientation (NRC, 1996).

They perceived that they disfavoured the "bright children who already have a great deal of knowledge," the "more advanced students because I think they can 'get it on their own' " (December 1998) or the "independent" child in their teaching. They thought they focused on those children who were "not staying on task" or "need[ed] more help and assistance" (December 1998). Additionally, one prospective teacher indicated that, prior to explicit attention to equity issues in science teaching and learning during the course, he had "never thought about much [equity in science learning]" (December 1998).

Challenges and Questions of Curiousity

Becoming aware, articulating, examining and changing beliefs, an elusive construct (Pajares, 1992), is difficult, complex and not well understood. I suggest a corollary, that becoming aware, articulating, examining and changing beliefs about equity in education in general and science education in particular is difficult, complex and not well understood. Major contributing factors stem from the diversity of conceptions of what equity in education is and the significance assigned to examination of equity issues in education. Nevertheless, creating equitable education continues to challenge the educational community, regardless who the learner is (Division of Elementary, Secondary, and Informal Education, 1997) – practicing teacher, prospective teacher, K-12 student, or teacher educator.

As a reflective teacher educator, I ask myself, "What connections are my students making when equity is addressed from a 'holistic' perspective? How can I help my students understand that equity is more than a checklist for developing teaching practices or a mechanism for analyzing curriculum materials and assessment tools? How can I help my students understand that equity is a way of relating within the social worlds of which they are members, their past and current worlds of schooling, and their future as classroom teachers?" These are my personal challenges and questions of curiousity.

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APPENDIX B

FROM PARALLEL UNIVERSES: BUILDING EQUITABLE CLASSROOM ENVIRONMENTS FROM THE GROUND UP THROUGH SCIENCE AND SPECIAL EDUCATORS' COLLABORATION

Eric J. Pyle, West Virginia University

As a high school science teacher, I faced many challenges. The school system that I taught in shared many characteristics with both rural and inner-city schools, and so resources were often tight and many students faced limited options once they had completed high school. One of the most vexing issues was providing adequate and appropriate instruction for the students with special needs that were included in my classes, often with little or no support from the special education teachers. Other than the occasional invitation to meet with a student' parents and other teachers, I often was on my own to meet a particular student's educational needs. Very rarely was an individualized education plan (IEP) made available to me if I was even informed of a student's special needs at all. When we discovered that our son had special needs, the perspective was suddenly changed. Now I was forced to be on both sides of the table.

My role as a science teacher educator brings me into contact with large numbers of teachers in diverse schools. West Virginia has made a considerable investment in school building in the last few years, but considerable disparities still exist in terms of the

resources available within those schools, both material and personnel Yet in these schools I have found a sincere desire for most science teachers to effectively promote learning by student with special needs that have been included in their classes. This desire to serve their students' needs is often offset by an intense frustration with their lack of time or expertise in dealing with specific disabilities in the context of their own classroom and the demands of the state-mandated curriculum. Many of these teachers felt that inclusion was "just one more thing" to draw upon their already limited time during the day.

Conversations with my colleague in special education revealed similar concerns coming from the special education teachers that she worked with, but from a different perspective. The special education teachers expressed frustration over not having a sufficient depth of content knowledge to their students to learn content. We thus formed a theory that a paradox existed, such that teachers might be driven to provide either content instruction without student-centered pedagogy or pedagogy without content.

Toward our interest in better preparing science and special education teachers to deal with such a paradox, we decided that teachers from both groups had a considerable depth of expertise from which to draw on. By creating an opportunity for these teachers to collaborate from a position of strength and not deficit, a project was developed such that science and special education teachers would be paired to bring together their

knowledge of science content and the science curriculum as well as disability-specific pedagogies.

One problem that was faced was developing the means of communication. My colleague and I needed to develop a negotiated sense of role, communication, and time management that paralleled the early work to the teacher pairs. We had the basic educational lexicon in common, but the stylistics of communication necessary for effectively completing our collaborative goals were lacking. We were able to share our terminology and approaches but not all the meaning behind them. We began to use the tools of collaboration suggested by Finson (1998), though our intrinsic motivation, commitment, and valued knowledge base. What was required to go beyond abstract products, such as lists of accommodations for special needs students divorced from specific settings, was a common currency to focus on, a context that provided concrete support to the abstract nature of our discussions.

The currency became short cases or vignettes that each represented a student with a special need or needs, as well as a prototypical Individualized Education Plan (IEP). The cases that we developed and subsequently had the participants in our project develop, each represented a student that someone in the group had had direct personal experience with. The cases described the student's background, academic and family history (to the extent known), the nature and extent of the student's deficits, strengths, and categorized

disabilities. The case was completed with an overview of the student's IEP and appropriate modifications and accommodations.

Using the case one focal point, the participants developed lessons that included by design specific accommodations matching the IEP. The lessons were based directly on the state science curriculum and were coordinated by a content theme used across grades, which served as a second focal point. The lessons thus reflected a synthesis of two sets of mandates, the state curriculum and the dictates represented by the IEP. Each member of the pair brought together their own specialized teaching lexicon and developed a stylistic language that was manifested in their lesson plans.

It became evident as the lessons were developed that the very notion of inclusion was no longer intimidating to the science teachers, nor was the science content a source of deep concern for the special education teachers. In fact, they came to realize that through their efforts of inclusion by design, they would be creating an environment that would enhance the learning for all of their students, whether they had identified special needs or not. Teachers now have a potential to develop a clear means of collaboration and everyday language so that time need not be expended on learning the other teachers point of view with respect their students' needs. Ideally, science and special education teachers can work towards co-teaching and co-planning that the actual, day-to-day instruction is seamless and it becomes difficult for outside observers to distinguish one

teacher or one student from another. And where school resources do not allow for such daily contact between teachers, what little time to co-plan that exists for the science and special education teacher can be maximized in that they know exactly how to stylize their discussions to meet their students' needs in the limited time frame.

We are each provided with different strengths and weaknesses, but when the instructional environment supports each student's use of their strengths to work towards their maximum potential, we set the ground work for equitable conditions beyond school. Close collaboration between professional educators in the interests of students must be supported and maintained if an equitable environment is to be created in schools. Not only does the inclusion arena offer a great potential for supporting equity, equity is mandated by the laws and regulations supporting special education.

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